Latchup Test Considerations for Analog-to-Digital Converters*

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Outline

Basic Considerations for Latchup and Latchup Testing

Latchup Characteristics of the 9240 ADC

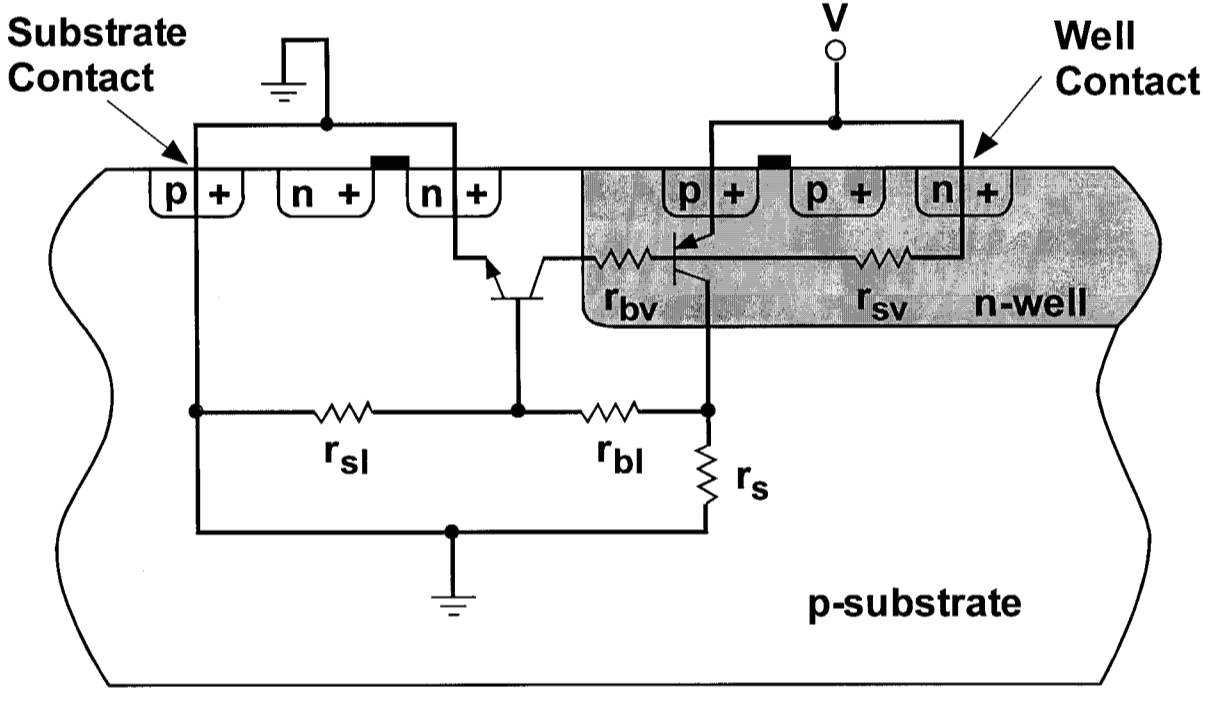
Identification of Latchup Regions

- Experimental technique
- Examples of latched regions
- Current distributions

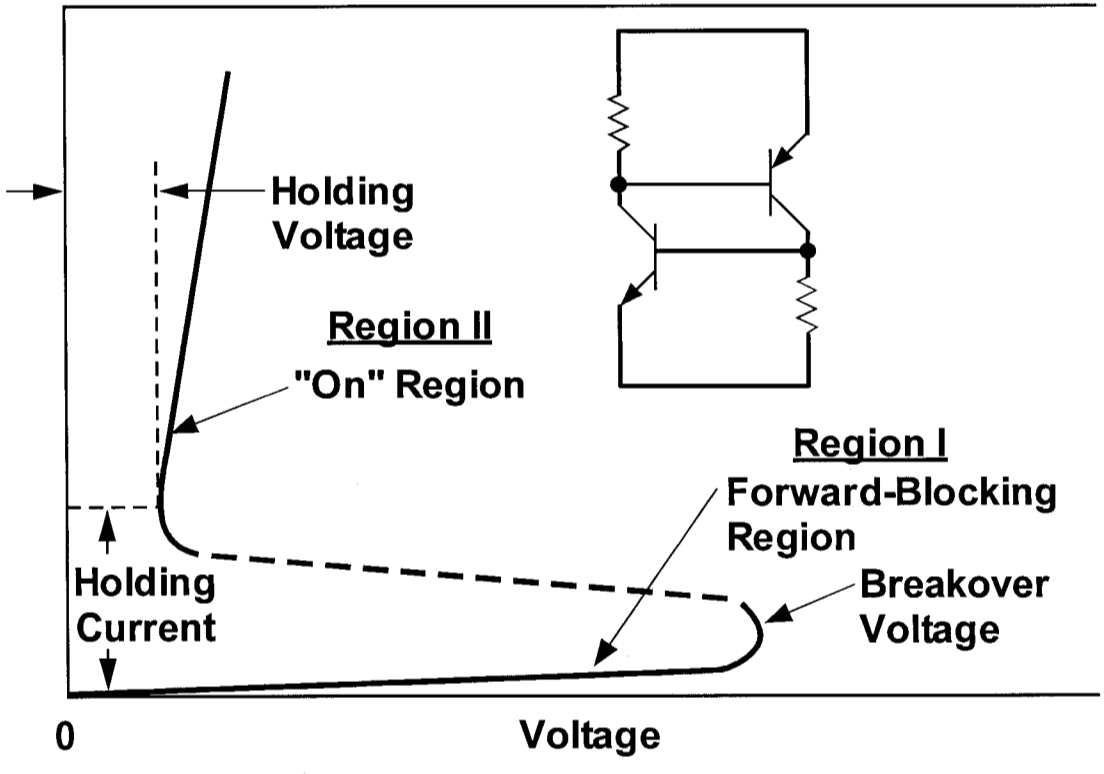
Characterization Requirements for Latchup in Complex Circuits

Conclusions

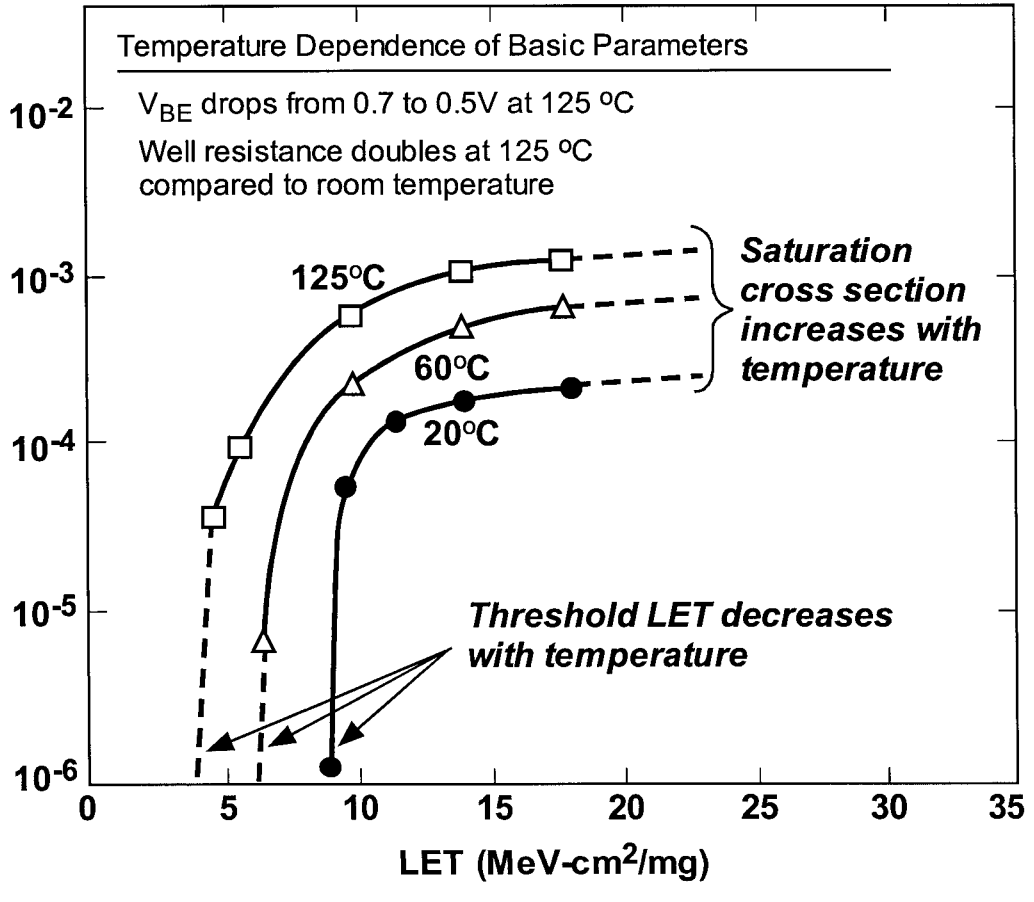
Latchup Path in a CMOS Circuit



I-V Characteristics for Latchup



Effect of Temperature on Latchup



Experimental Approach

Samples Chemically Etched to Remove Top of Plastic Package

Tests Done Using Three Different Facilities

- Brookhaven
- Texas A&M
- Californium-252 (limited ion range)

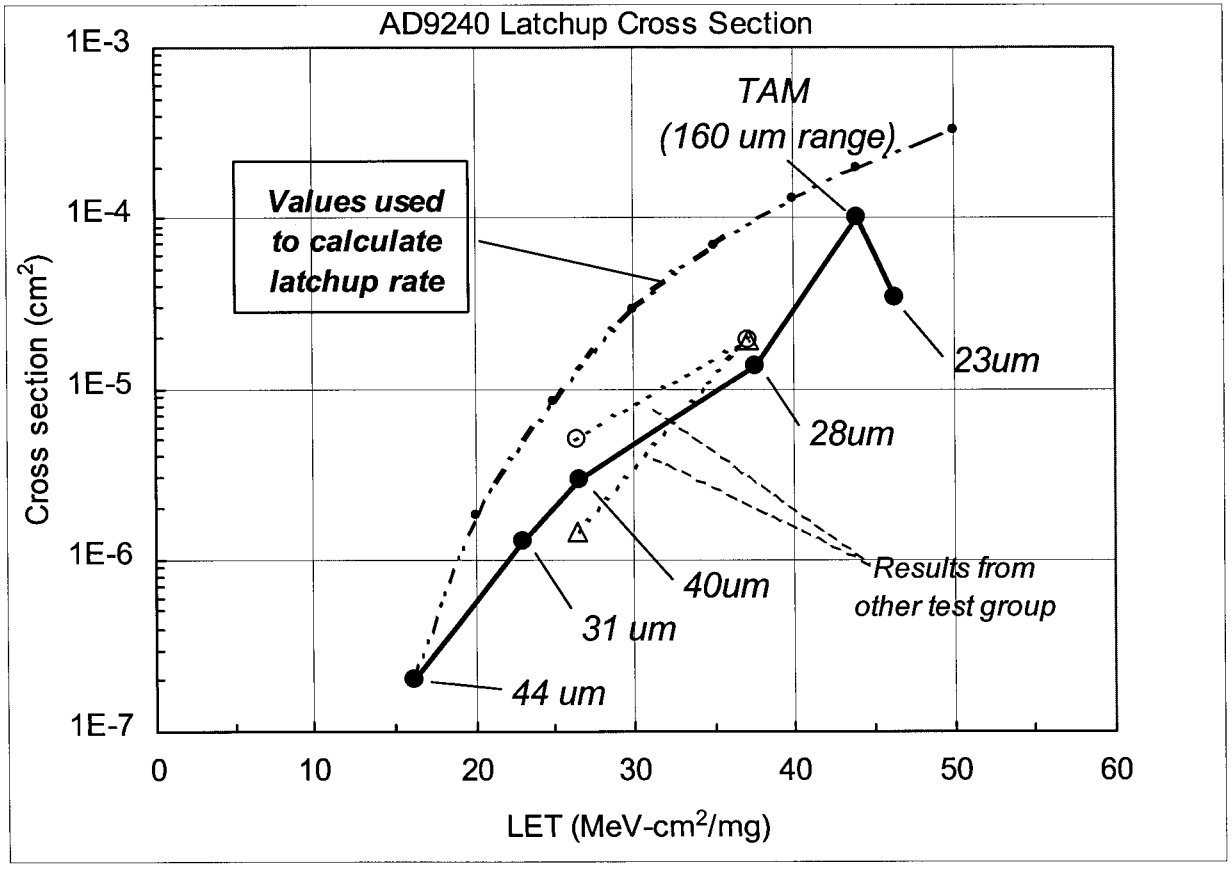
Currents Continually Monitored During Testing

- Current "signatures" identify latchup
- Some tests done over extended time periods to investigate catastrophic failure

Special Diagnostic Tests Used to Determine Latchup Regions

- Thermal imaging used to locate latchup region
- Allow surface temperature to be measured

Cross Section for Latchup in the 9240 ADC



Equilibrium Currents During Latchup

Power Supply	Initial Current (mA)	Final Current (mA)
#1 - Digital Section	4.6	65 to 177
#2 - Analog Section	58	74 to 380

Issues Relating to Current Detection and Shutdown

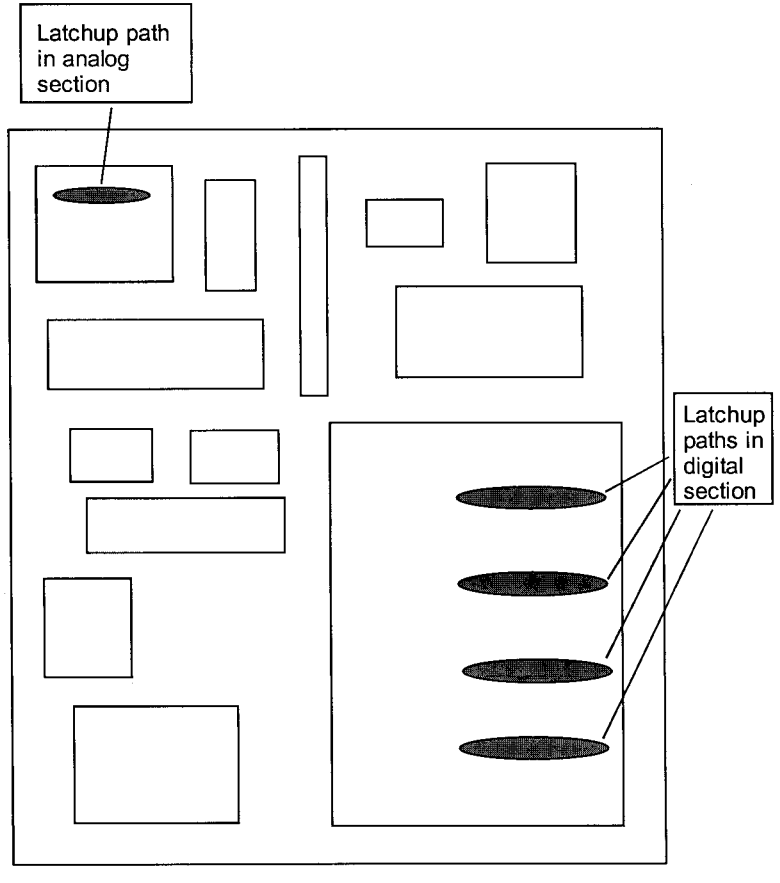
Latchup Occurs in Two Distinctly Different Regions

- Both analog and digital regions exhibit latchup
- Latchup monitoring must include both sections
- Current limiting can alter results

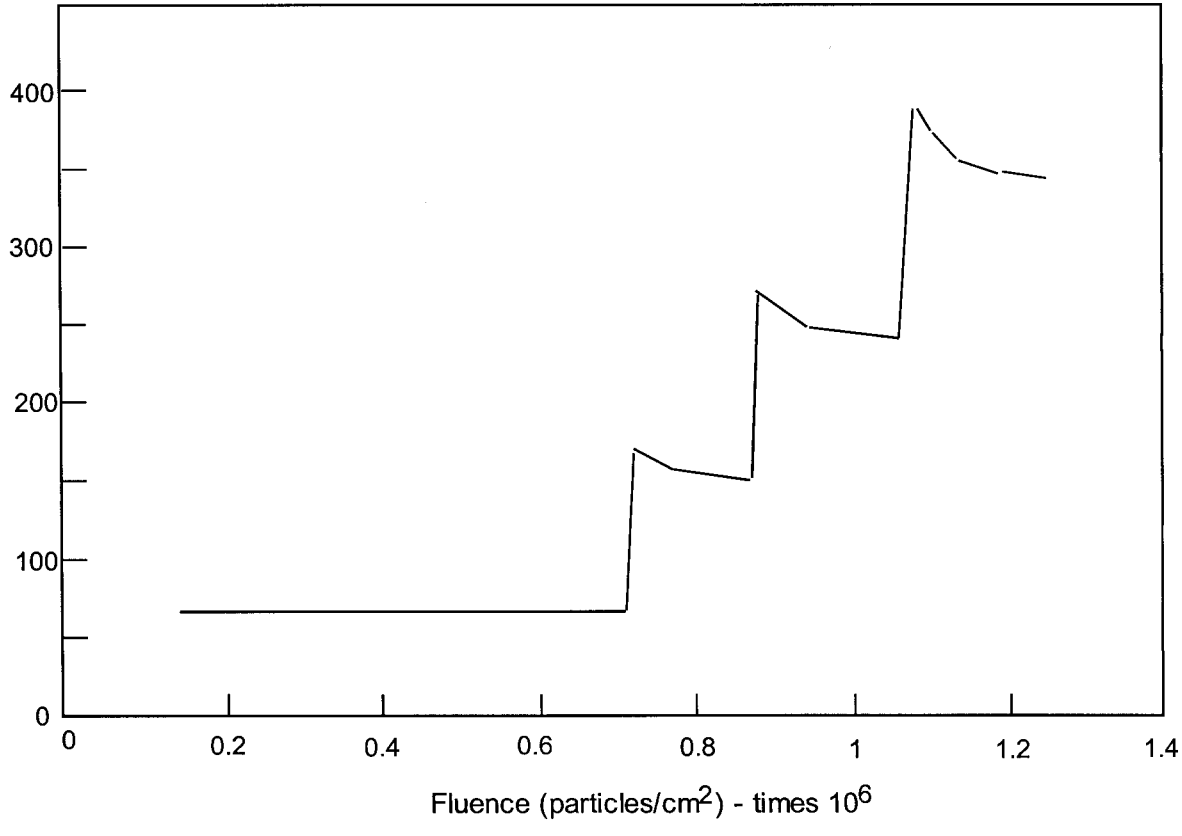
Detection Limits Are Difficult to Establish

- Wide range of currents during latchup
- Temperature, unit-to-unit variations must be considered
- Transient currents during normal operation must be allowed for

Latchup Sites in the 9240 Analog-to-Digital Converter



Multiple Latchup Events in the 9240 ADC



Latchup Characterization Requirements

Extensive Testing Is Required

- Determine various latchup paths and conditions
- Temperature and device variability can be important
- Catastrophic failure conditions must be determined

Equilibrium Current Is a Useful Parameter

- Heating in vacuum is a potential interference
- Voltage drop in cabling must be low at high currents

Latchup Rates Are Often Dominated by "Knee" Region

Conclusions

Latchup in Complex Devices Is Difficult to Characterize

- Numerous latchup paths are present
- Equilibrium conditions vary widely

Current Limiting Power Supplies May Alter Latchup Results

Ions Used for Testing Must Have Adequate Range

- At least 40 μm for devices with bulk substrates
- Surface metallization and contacts must be consider

Thermal Imaging Is a Useful Diagnostic Technique